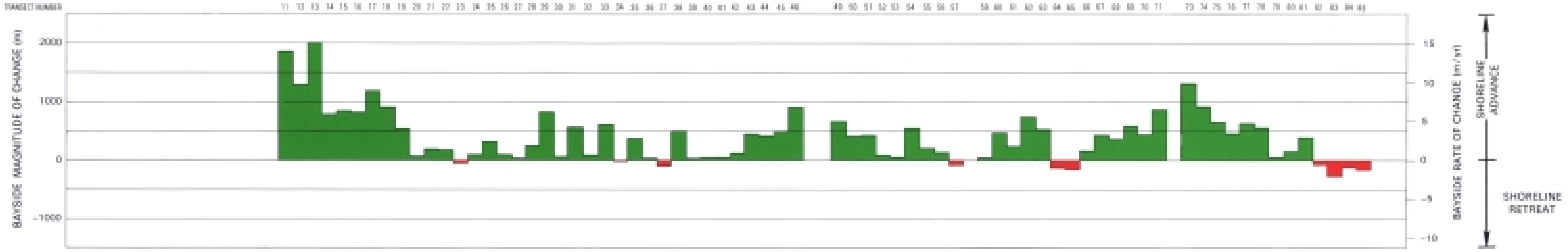
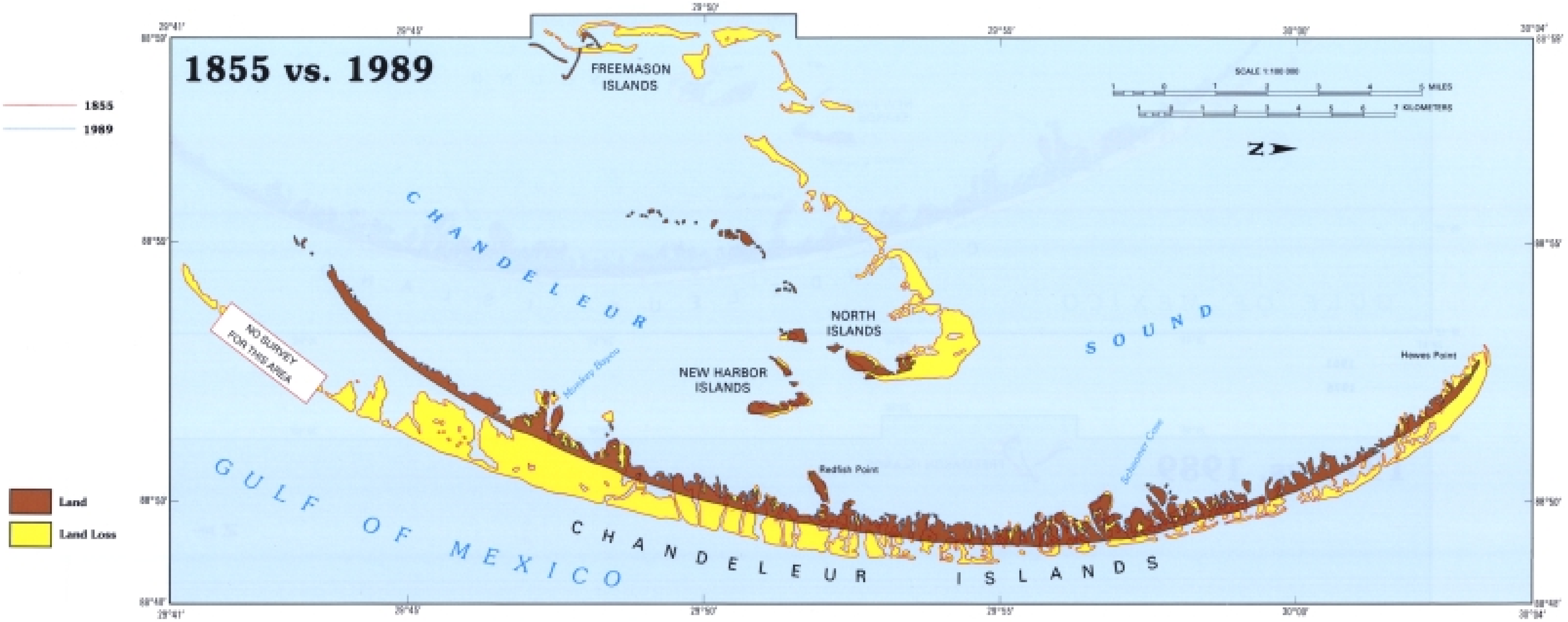
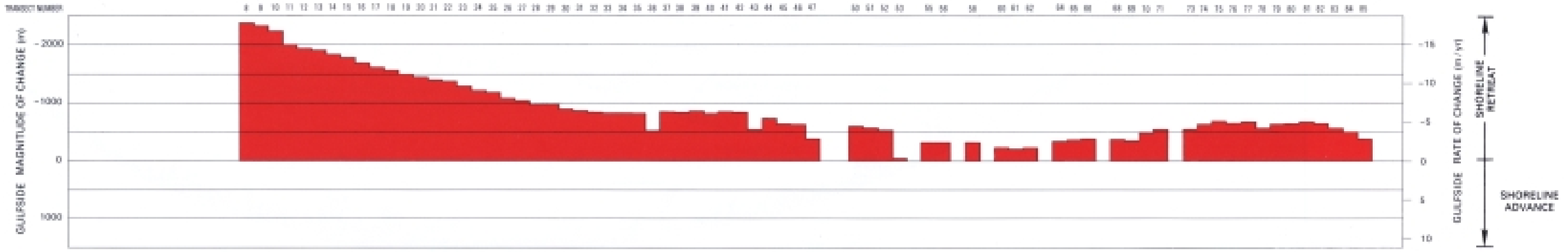
North Chandeleur Islands







North Chandeleur Islands

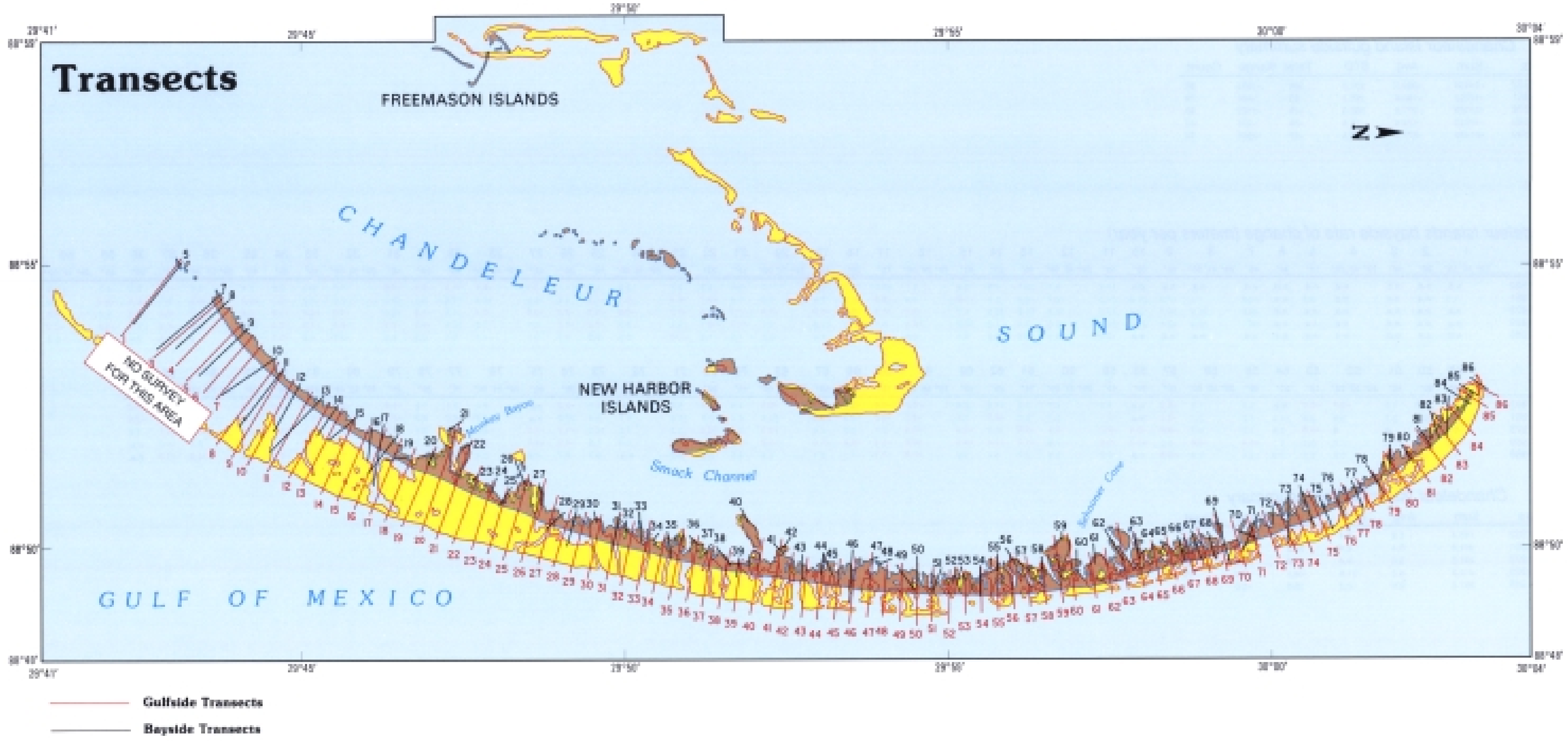


TABLE 39.—*North Chandeleur Islands bayside magnitude of change (meters)*

Transect #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Transect coordinate		29° 42' 15"	30"	45"	29° 43' 00"	15"	30"	45"	29° 44' 00"	15"	30"	45"	29° 45' 00"	15"	30"	45"	29° 46' 00"	15"	30"	45"	29° 47' 00"	15"	30"	45"	29° 48' 00"
Y	1855–1922	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.a.	n.a.	n.a.	726	277	1009	118	226	546	1060	732	362	60	106	215	5	287
ø	1922–1951	42	n.a.	n.a.	n.a.	281	n.a.	479	39	495	709	610	460	5	31	−45	272	−152	251	224	14	38	−20	−11	−177
ß	1951–1978	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1251	1276	727	337	362	467	713	611	270	−8	−58	−64	−188	−23	−38	−18	−33	−9
r	1978–1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	479	384	424	332	223	88	8	14	400	−1	1	6	124	1	−7	−7	1	3
ε	1855–1989	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.a.	n.a.	n.a.	1681	1282	2009	779	890	809	1174	923	545	61	198	173	−38	74

Transect #		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Transect coordinate		15"	30"	45"	29° 49' 00"	15"	30"	45"	29° 50' 00"	15"	30"	45"	29° 51' 00"	15"	30"	45"	29° 52' 00"	15"	30"	45"	29° 53' 00"	15"	30"	45"	29° 54' 00"
Y	1855–1922	359	72	−410	−251	−98	−21	−330	68	604	98	161	137	−91	558	22	37	65	62	595	25	94	695	n.a.	n.a.
ø	1922–1951	−88	60	439	471	808	91	382	37	24	−33	−8	−93	19	−15	−245	38	−12	38	−16	27	−76	−61	−12	−7
ß	1951–1978	−8	−9	−17	−2	129	−29	510	−27	−24	−27	−7	−19	−21	−32	234	−44	−14	−8	−53	−19	132	36	−28	−9
r	1978–1989	−2	−14	1	14	279	−5	−4	−8	−16	−5	217	8	−8	3	−9	−3	0	−2	8	366	334	60	−18	−10
ε	1855–1989	295	93	10	232	615	95	558	91	604	−8	369	4	−102	512	2	28	39	118	640	400	492	900	n.a.	n.a.

Transect #		49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Transect coordinate		15"	30"	45"	29° 55' 00"	15"	30"	45"	29° 56' 00"	15"	30"	45"	29° 57' 00"	15"	30"	45"	29° 58' 00"	15"	30"	45"
Y	1855–1922	371	118	202	−44	−46	n.a.	23	71	−13	n.a.	118	319	63	786	453	−44	−42	−306	−354
ø	1922–1951	279	20	77	105	88	416	151	59	−58	n.a.	−3	144	236	−83	63	−60	−92	487	766
ß	1951–1978	−8	3	1	0	−14	87	52	3	−17	−13	−76	−88	−63	20	−6	−8	2	20	18
r	1978–1989	−2	271	1	7	4	11	−18	−8	3	−11	−9	82	−13	−18	−9	−9	−18	−9	−12
ε	1855–1989	637	404	411	68	38	624	193	118	−86	n.a.	31	464	222	721	809	−117	−147	146	418

Transect #		68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Transect coordinate		29° 59' 00"	15"	30"	45"	30° 00' 00"	15"	30"	45"	30° 01' 00"	15"	30"	45"	30° 02' 00"	15"	30"	45"	30° 03' 00"	15"	30"
Y	1855–1922	−238	234	232	413	n.a.	753	−148	n.a.	739	142	81	−64	−217	−83	−271	−637	−225	−312	−99
ø	1922–1951	664	164	219	382	185	138	1099	n.a.	257	236	259	−66	369	445	204	279	22	53	−76
ß	1951–1978	−88	165	−17	32	49	402	−48	−80	116	229	94	−52	6	30	−15	88	−4	−3	108
r	1978–1989	−8	−36	0	12	4	15	−8	−14	−52	11	118	206	−12	−3	11	14	133	104	n.a.
ε	1855–1989	334	568	436	859	n.a.	1309	499	844	467	612	681	41	145	389	−71	−284	−104	−158	n.a.

Chandeleur Island bayside summary

Years	Sum	Avg	STD	Total	Range	Count
1855–1922	10498	149.9	263.0	1060	−637	70
1922–1951	12430	155.4	242.3	1099	−245	80
1951–1978	7260	90.8	260.9	1251	−188	80
1978–1989	4368	55.3	133.4	479	−52	79
1855–1989	27833	391.9	443.5	2009	−284	71

See page 46 for explanation of numbers.

North Chandeleur Islands

TABLE 40.—*North Chandeleur Islands gulfside magnitude of change (meters)*

Transect #		1	2	3	4	5	6	7	8	9	10	11	12
Transect coordinate		29° 42' 15"	30"	45"	29° 43' 00"	15"	30"	45"	29° 44' 00"	15"	30"	45"	29° 45' 00"
Y	1855–1922	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	−992	−1003	−877	−860	−836
α	1922–1951	−411	n.a.	−451	n.a.	−311	−283	−314	−342	−450	−293	−276	−273
β	1951–1978	n.a.	n.a.	−1459	n.a.	−1261	−1107	−862	−775	−606	−721	−658	−608
γ	1978–1989	n.a.	n.a.	−278	−265	−229	−254	−266	−259	−250	−238	−208	−216
δ	1855–1989	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	−2368	−2319	−2229	−1999	−1924

Transect #		13	14	15	16	17	18	19	20	21	22	23	24
Transect coordinate		15"	30"	45"	29° 46' 00"	15"	30"	45"	29° 47' 00"	15"	30"	45"	29° 48' 00"
Y	1855–1922	−822	−843	−849	−790	−733	−718	−667	−642	−693	−618	−536	−534
α	1922–1951	−285	−242	−227	−247	−286	−232	−253	−272	−287	−263	−238	−230
β	1951–1978	−563	−538	−565	−416	−381	−337	−302	−253	−239	−233	−231	−248
γ	1978–1989	−218	−223	−245	−231	−218	−225	−234	−256	−237	−228	−214	−175
δ	1855–1989	−1888	−1851	−1785	−1684	−1599	−1524	−1488	−1433	−1297	−1302	−1277	−1207

Transect #		25	26	27	28	29	30	31	32	33	34	35	36
Transect coordinate		15"	30"	45"	29° 49' 00"	15"	30"	45"	29° 50' 00"	15"	30"	45"	29° 51' 00"
Y	1855–1922	−483	−502	−470	−463	−412	−361	−329	−341	−321	−286	−318	−13
α	1922–1951	−237	−192	−175	−139	−139	−149	−140	−109	−132	−129	−121	−147
β	1951–1978	−241	−235	−243	−239	−233	−273	−267	−286	−281	−281	−279	−256
γ	1978–1989	−193	−146	−125	−108	−92	−99	−112	−103	−88	−88	−101	−101
δ	1855–1989	−1164	−1075	−1013	−971	−858	−893	−848	−838	−823	−803	−811	−617

Transect #		37	38	39	40	41	42	43	44	45	46	47	48
Transect coordinate		15"	30"	45"	29° 52' 00"	15"	30"	45"	29° 53' 00"	15"	30"	45"	29° 54' 00"
Y	1855–1922	−351	−323	−335	−320	−326	−301	−69	−283	−191	−221	21	n.a.
α	1922–1951	−147	−146	−130	−146	−159	−132	−127	−112	−96	−90	−85	−82
β	1951–1978	−250	−260	−239	−216	−245	−255	−242	−236	−238	−238	−221	−227
γ	1978–1989	−104	−162	−157	−119	−108	−93	−92	−91	−81	−66	−84	−151
δ	1855–1989	−852	−831	−858	−805	−831	−831	−525	−734	−615	−618	−372	n.a.

Transect #		49	50	51	52	53	54	55	56	57	58	59	60
Transect coordinate		15"	30"	45"	29° 55' 00"	15"	30"	45"	29° 56' 00"	15"	30"	45"	29° 57' 00"
Y	1855–1922	n.a.	−181	−108	−92	204	n.a.	32	22	n.a.	n.a.	n.a.	−7
α	1922–1951	−109	−86	−154	−171	−184	−172	−126	−164	−86	n.a.	−71	−32
β	1951–1978	−216	−208	−171	−174	−181	−163	−167	−164	−141	−134	−123	−125
γ	1978–1989	−92	−89	−91	−83	−81	−78	−68	−61	−63	−55	−60	−60
δ	1855–1989	n.a.	−563	−548	−520	−22	n.a.	−303	−287	n.a.	−300	n.a.	−224

Transect #		61	62	63	64	65	66	67	68	69	70	71	72
Transect coordinate		15"	30"	45"	29° 58' 00"	15"	30"	45"	29° 59' 00"	15"	30"	45"	30° 00' 00"
Y	1855–1922	5	−61	n.a.	−91	−72	−55	n.a.	n.a.	−119	−250	−320	n.a.
α	1922–1951	−53	−16	−31	−72	−68	−56	n.a.	n.a.	−55	−45	−3	n.a.
β	1951–1978	−92	−89	−95	−100	−117	−112	−109	−81	−79	−75	−102	−106
γ	1978–1989	−56	−49	−45	−54	−69	−71	−63	−61	−79	−106	−80	−62
δ	1855–1989	−196	−215	n.a.	−326	−347	−353	n.a.	−365	−329	−477	−517	n.a.

Transect #		73	74	75	76	77	78	79	80	81	82	83	84	85	86
Transect coordinate		15"	30"	45"	30° 01' 00"	15"	30"	45"	30° 02' 00"	15"	30"	45"	30° 03' 00"	15"	30"
Y	1855–1922	−377	−387	n.a.	−417	−345	−172	−221	−298	−388	−338	−241	−148	−77	88
α	1922–1951	27	−51	n.a.	−138	−234	−264	−229	−123	−80	−94	−90	−91	40	88
β	1951–1978	−107	−110	−106	−54	−10	−29	−71	−91	−81	−100	−171	−194	−272	−123
γ	1978–1989	−42	−58	−51	−38	−68	−90	−110	−123	−116	−91	−53	−79	−126	n.a.
δ	1855–1989	−639	−616	−668	−647	−666	−646	−622	−630	−655	−621	−555	−472	−287	n.a.

Chandeleur Island gulfside summary

Years	Sum	Avg	STD	Total	Range	Count
1855–1922	−24433	−359.3	291.1	204	−1003	68
1922–1951	−12702	−160.8	108.1	88	−480	79
1951–1978	−23069	−277.9	260.3	−10	−1459	83
1978–1989	−10623	−128.0	73.8	−38	−286	83
1855–1989	−61423	−877.5	553.6	−22	−2388	70

TABLE 41.—*North Chandeleur Islands bayside rate of change (meters per year)*

Transect #		1	2	3	4	5	6	7	8	9	10	11	12
Transect coordinate		29° 42' 15"	30"	45"	29° 43' 00"	15"	30"	45"	29° 44' 00"	15"	30"	45"	29° 45' 00"
Y	1855–1922	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.a.	n.a.	n.a.	13.9	4.1
α	1922–1951	1.8	n.a.	n.a.	n.a.	8.8	n.a.	50.3	1.4	17.2	24.8	21.2	16.7
β	1951–1978	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	40.6	45.9	26.2	12.1	19.9	16.6
γ	1978–1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	40.1	36.9	40.6	31.9	21.4	5.6
δ	1855–1989	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.a.	n.a.	n.a.	13.9	9.5

Transect #		13	14	15	16	17	18	19	20	21	22	23	24
Transect coordinate		15"	30"	45"	29° 46' 00"	15"	30"	45"	29° 47' 00"	15"	30"	45"	29° 48' 00"
Y	1855–1922	18.1	1.6	0.4	6.1	20.2	10.9	5.4	1.0	2.9	3.2	0.1	0.8
α	1922–1951	6.2	1.1	−1.6	9.4	−9.3	6.7	7.8	0.5	1.4	−0.7	−0.4	−6.1
β	1951–1978	25.6	22.0	9.7	−0.3	−1.3	−3.0	−0.8	−0.8	−1.1	−0.8	−1.2	−0.3
γ	1978–1989	5.4	1.3	38.5	−0.1	0.1	0.4	11.9	0.1	−0.7	−0.7	0.1	0.3
δ	1855–1989	15.0	5.6	6.3	6.3	8.7	6.7	4.1	0.5	1.5	1.3	−0.3	0.8

Transect #		25	26	27	28	29	30	31	32	33	34	35	36
Transect coordinate		15"	30"	45"	29° 49' 00"	15"	30"	45"	29° 50' 00"	15"	30"	45"	29° 51' 00"
Y	1855–1922	5.0	1.1	−6.1	−3.7	−1.5	−0.3	−4.8	1.0	0.3	0.8	2.4	1.6
α	1922–1951	−1.8	1.4	15.2	18.4	17.6	3.2	13.0	2.0	0.8	−1.1	−0.2	−0.2
β	1951–1978	−0.2	−0.2	−0.8	−0.1	4.6	−1.0	16.5	−1.0	−0.8	−1.0	−0.3	−0.7
γ	1978–1989	−0.2	−1.3	0.1	1.5	26.8	−0.8	−0.6	−0.6	−1.6	−0.8	20.9	0.9
δ	1855–1989	2.2	0.7	6.1	1.7	6.1	0.3	4.2	0.7	4.8	−0.1	2.7	0

Transect #		37	38	39	40	41	42	43	44	45	46	47	48
Transect coordinate		15"	30"	45"	29° 52' 00"	15"	30"	45"	29° 53' 00"	15"	30"	45"	29° 54' 00"
Y	1855–1922	−1.4	0.0	0.3	0.5	1.0	1.2	7.6	0.4	1.4	13.0	n.a.	n.a.
α	1922–1951	0.7	−0.5	−8.5	1.3	−0.4	1.3	−0.6	0.8	−2.7	−0.2	−4.4	−0.2
β	1951–1978	−0.6	−1.2	0.4	−1.0	−0.5	−0.3	−1.9	−0.7	8.1	1.3	−4.7	−0.3
γ	1978–1989	−0.8	0.5	−3.9	−0.3	0	−0.2	0.5	30.2	32.1	5.6	−1.6	−1.0
δ	1855–1989	−0.8	0.6	0	0.2	0.3	0.8	3.3	3.3	3.7	6.7	n.a.	n.a.

Transect #		49	50	51	52	53	54	55	56	57	58	59	60
Transect coordinate		15"	30"	45"	29° 55' 00"	15"	30"	45"	29° 56' 00"	15"	30"	45"	29° 57' 00"
Y	1855–1922	5.5	1.6	4.8	−0.7	−0.8	n.a.	0.4	1.1	−0.2	n.a.	1.8	4.7
α	1922–1951	6.6	0.7	2.7	3.8	3.0	14.4	8.2	1.7	−2.0	n.a.	−0.1	5.1
β	1951–1978	−0.3	0.1	0	0	−0.5	3.8	1.2	0.1	−0.6	−0.4	−2.7	−3.1
γ	1978–1989	−0.2	26.1	0.1	0.7	0.4	1.1	−1.4	−6.8	0.2	−1.1	−0.8	7.9
δ	1855–1989	4.7	3.0	3.1	0.8	0.3	2.8	1.4	0.9	−0.6	n.a.	0.2	3.5

Transect #		61	62	63	64	65	66	67	68	69	70	71	72
Transect coordinate		15"	30"	45"	29° 58' 00"	15"	30"	45"	29° 59' 00"	15"	30"	45"	30° 00' 00"
Y	1855–1922	1.2	11.9	6.9	−0.7	−0.8	−8.0	−5.3	−0.8	3.5	0.4	6.6	n.a.
α	1922–1951	8.2	−2.9	2.2	−2.1	−3.2	15.2	26.5	23.9	8.4	7.6	10.3	6.7
β	1951–1978	−3.0	0.7	−0.3	−0.3	0.1	0.9	0.6	−3.2	6.7	−0.6	1.2	1.8
γ	1978–1989	−1.3	−1.4	−0.9	−0.8	−1.4	−0.9	−1.0	−0.8	−3.6	0.3	1.2	0.4
δ	1855–1989	1.7	5.4	0.8	−0.8	−1.1	1.1	0.1	2.6	4.2	3.2	6.5	n.a.

Transect #		73	74	75	76	77	78	79	80	81	82	83	84	85	86
Transect coordinate		15"	30"	45"	30° 01' 00"	15"	30"	45"	30° 02' 00"	15"	30"	45"	30° 03' 00"	15"	30"
Y	1855–1922	11.2	−2.2	n.a.	2.0	2.1	1.2	−1.0	−3.2	−1.2	−4.0	−8.5	−3.5	−4.6	−1.5
α	1922–1951	4.6	30.2	n.a.	8.9	4.8	8.0	−2.4	12.8	16.5	7.1	9.6	0.8	1.9	−2.8
β	1951–1978	14.5	−1.7	−2.2	4.2	4.2	2.4	−1.9	0.1	1.1	−0.8	3.1	−0.1	−0.1	2.6
γ	1978–1989	1.6	−0.9	−1.3	−5.0	1.1	11.3	21.6	−1.2	−0.3	1.1	1.3	9.9	10.0	n.a.
δ	1855–1989	9.7	6.7	4.6	3.4	4.8	4.7	0.3	1.1	2.9	−0.8	−2.0	−0.8	−1.2	n.a.

Chandeleur Island bayside summary

Years	Sum	Avg	STD	Total	Range	Count
1855–1922	155.4	2.2	5.4	20.2	−8.5	70
1922–1951	431.6	5.4	8.4	38.2	−8.5	80
1951–1978	261.2	3.3	9.4	45.6	−5.9	80
1978–1989	419.8	5.3	11.8	40.1	−6.0	79
1855–1989	207.2	2.9	3.3	15.0	−2.0	71

TABLE 42.—*North Chandeleur Islands width measurements (meters)*

Transect #		1	2	3	4	5	6	7	8	9	10	11	12
Transect coordinate		29° 42' 15"	30"	45"	29° 43' 00"	15"	30"	45"	29° 44' 00"	15"	30"	45"	29° 45' 00"
Y	1855	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	298	518	1323	82	1369
α	1922	553	357	527	268	333	158	287	481	309	473	216	760
β	1951	292	n.a.	153	n.a.	107	557	412	467	491	538	492	473
γ	1978	n.a.	n.a.	21	21	108	95	284	156	203	361	326	302
δ	1989	20	24	227	226	373	374	261	204	108	175	181	319

Transect #		13	14	15	16	17	18	19	20	21	22	23	24
Transect coordinate		15"	30"	45"	29° 46' 00"	15"	30"	45"	29° 47' 00"	15"	30"	45"	29° 48' 00"
Y	1855	1361	1584	1468	1507	1462	1291	1808	2853	2386	1616	1504	1257
α	1922	883	718	867	1464	971	625	1342	2163	1976	1192	1154	1093
β	1951	246	572	824	1099	1061	696	1058	1844	1587	914	769	765
γ	1978	437	42	418	632	862	216	769	1587	1429	622	515	513
δ	1989	290	235	170	404	375	130	512	1303	1181	398	298	310

Transect #		25	26	27	28	29	30	31	32	33	34	35	36
Transect coordinate		15"	30"	45"	29° 49' 00"	15"	30"	45"	29° 50' 00"	15"	30"	45"	29° 51' 00"
Y	1855	1965	1656	1108	726	638	1368	940	1294	1011	1110	1630	2108
α	1922	1534	1034	447	385	41	1383	328	989	202	872	1268	1061
β	1951	1366	1211	299	386	658	937	570	446	626	685	1163	868
γ	1978	1184	958	517	133	441	842	380	581	894	404	733	878
δ	1989	923	841	417	171	388	951	686	469	868	487	701	863

Transect #		37	38	39	40	41	42	43	44	45	46	47	48
Transect coordinate		15"	30"	45"	29° 52' 00"	15"	30"	45"	29° 53' 00"	15"	30"	45"	29° 54' 00"
Y	1855	981	989	1012	1618	1611	1280	600	1026	743	775	675	n.a.
α	1922	639	733	713	893	1403	847	958	768	506	485	633	958
β	1951	609	600	338	842	1170	781	871	664	410	572	676	865
γ	1978	296	340	238	708	916	485	868	423	178	341	472	712
δ	1989	680	232	178	878	801	389	448	607	515	568	368	602

Transect #		49	50	51	52	53	54	55	56	57	58	59	60
Transect coordinate		15"	30"	45"	29° 55' 00"	15"	30"	45"	29° 56' 00"	15"	30"	45"	29° 57' 00"
Y	1855	240	825	687	983	554	n.a.	865	1170	278	867	596	1698
α	1922	764	377	388	296	252	429	1023	1045	968	n.a.	1519	1558
β	1951	938	646	262	276	744	865	1053	1224	678	679	1521	1608
γ	1978	719	455	435	316	658	810	920	1068	262	780	1403	1498
δ	1989	624	629	543	398	468	560	632	995	342	674	1331	1419

Transect #		61	62	63	64	65	66	67	68	69	70	71	72
Transect coordinate		15"	30"	45"	29° 58' 00"	15"	30"	45"	29° 59' 00"	15"	30"	45"	30° 00' 00"
Y	1855	770	817	81	716	929	790	334	512	24	544	742	n.a.
α	1922	884	767	294	1152	933	325	n.a.	n.a.	75	79	294	n.a.
β	1951	900	759	1528	1137	842	395	581	358	317	182	694	545
γ	1978	845	682	1451	1021	824	367	243	252	345	234	554	328
δ	1989	581	587	919	968	758	625	676	414	159	174	485	341

Transect #		73	74	75	76	77	78	79	80	81	82	83	84	85	86
Transect coordinate		15"	30"	45"	30° 01' 00"	15"	30"	45"	30° 02' 00"	15"	30"	45"	30° 03' 00"	15"	30"
Y	1855	57	383	196	227	624	142	367	1067	640	608	675	650	646	394
α	1922	185	53	n.a.	81	85	129	135	246	235	262	384	495	215	188
β	1951	259	488	712	147	180	218	180	387	503	97	428	570	276	272
γ	1978	257	495	862	281	258	238	201	417	424	529	195	119	135	128
δ	1989	465	351	615	130	305	172	196	387	313	440	276	225	134	n.a.

Chandeleur Island width summary

Years	Sum	Avg	STD	Total	Range	Count
1855	71185	940.6	542.8	2853	24	76
1922	54282	670.1	468.2	2163	41	81
1951	56699	675.1	387.8	1844	97	84
1978	42482	505.7	346.8	1587	21	84
1989	40358	474.8	296.7	1419	20	85

See page 46 for explanation of numbers.

North Chandeleur Islands

TABLE 43.—*North Chandeleur Islands gulfside rate of change (meters per year)*

Transect #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Transect coordinate		29° 42' 15"	30"	45"	29° 43' 00"	15"	30"	45"	29° 44' 00"	15"	30"	45"	29° 45' 00"	15"	30"	45"	29° 46' 00"	15"	30"	45"	29° 47' 00"	15"	30"	45"	29° 48' 00"	15"	30"	45"	29° 49' 00"	15"	30"	45"	29° 50' 00"	15"	30"	45"	29° 51' 00"	15"	30"	45"	29° 52' 00"	15"	30"	45"	29° 53' 00"	15"	30"	45"	29° 54' 00"
Y	1855–1922	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	−14.7	−14.8	−14.8	−12.8	−12.4	−12.2	−12.5	−12.8	−11.7	−10.9	−10.5	−9.9	−9.5	−9.7	−9.2	−9.3	−7.8	−7.3	−7.5	−7.2	−6.8	−6.6	−5.4	−4.9	−5.1	−4.6	−4.4	−4.6	−0.2	−3.2	−1.8	−1.9	−4.8	−4.9	−5.2	−1.0	−4.2	−2.8	−3.3	0.2	n.a.
e	1922–1951	−14.8	n.a.	−15.7	n.a.	−10.8	−9.8	−10.8	−11.8	−18.0	−10.2	−9.5	−9.5	−8.9	−8.4	−7.8	−8.6	−9.2	−8.4	−9.8	−9.4	−9.3	−9.2	−8.8	−8.7	−8.2	−8.7	−6.1	−4.8	−4.6	−5.1	−4.8	−3.6	−4.6	−4.8	−4.2	−0.1	−5.1	−5.1	−4.5	−5.1	−5.2	−4.6	−4.4	−3.9	−3.3	−3.1	−3.1	−3.8
a	1951–1978	n.a.	n.a.	−42.8	n.a.	−48.4	−39.8	−25.2	−27.9	−21.8	−25.9	−25.7	−21.5	−26.5	−18.5	−16.7	−15.0	−13.7	−12.8	−13.9	−8.5	−8.6	−8.2	−9.3	−8.9	−8.7	−8.3	−8.7	−9.3	−10.5	−9.9	−9.8	−10.3	−10.1	−10.1	−10.0	−9.2	−9.0	−9.4	−6.6	−7.6	−8.6	−9.2	−6.7	−8.8	−6.9	−6.6	−7.9	−8.2
r	1978–1989	n.a.	n.a.	−28.0	−27.5	−22.9	−24.4	−25.8	−24.5	−24.0	−22.9	−19.7	−20.8	−21.0	−21.4	−23.8	−22.2	−21.0	−21.8	−22.5	−24.8	−22.8	−21.7	−20.8	−15.8	−15.6	−14.0	−12.9	−10.4	−8.8	−8.5	−10.8	−9.8	−9.3	−8.4	−8.7	−9.7	−10.0	−9.6	−15.1	−11.4	−10.2	−8.8	−8.8	−8.8	−7.8	−8.5	−8.0	−8.7
s	1855–1989	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	−17.6	−17.3	−16.8	−12.8	−14.2	−14.1	−13.7	−13.3	−12.5	−11.9	−11.4	−11.1	−10.7	−10.4	−10.1	−9.5	−9.5	−8.7	−8.0	−7.8	−7.2	−7.1	−6.8	−6.3	−6.2	−6.1	−6.0	−6.0	−3.4	−6.3	−6.2	−6.4	−6.0	−6.2	−6.2	−3.9	−5.5	−4.6	−4.6	−2.8	n.a.

Transect #		49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Transect coordinate		15"	30"	45"	29° 55' 00"	15"	30"	45"	29° 56' 00"	15"	30"	45"	29° 57' 00"	15"	30"	45"	29° 58' 00"	15"	30"	45"	29° 59' 00"	15"	30"	45"	30° 00' 00"	15"	30"	45"	30° 01' 00"	15"	30"	45"	30° 02' 00"	15"	30"	45"	30° 03' 00"	15"	30"
Y	1855–1922	n.a.	−2.6	−2.1	−1.4	2.9	n.a.	0.7	0.6	n.a.	n.a.	n.a.	−0.1	0.1	−0.8	n.a.	−1.4	−1.7	−1.3	n.a.	n.a.	−7.8	−3.7	−4.8	n.a.	−5.8	−5.8	n.a.	−6.2	−5.1	−2.6	−3.5	−4.4	−5.5	−5.0	−3.6	−2.2	−1.7	0.8
e	1922–1951	−3.7	−3.3	−5.5	−5.9	−6.4	−6.5	−4.4	−3.6	−3.3	n.a.	−2.5	−1.1	−1.8	−0.8	−1.1	−2.5	−3.1	−3.0	n.a.	n.a.	−2.1	−1.0	−0.1	n.a.	5.9	−1.8	n.a.	−4.8	−8.1	−8.8	−7.8	−1.3	−3.1	−3.3	−3.1	−1.8	1.7	2.8
a	1951–1978	−7.7	−7.5	−6.2	−6.5	−5.4	−5.1	−5.6	−5.9	−5.1	−4.8	−4.4	−4.5	−3.3	−3.2	−3.4	−3.9	−4.2	−6.0	−3.8	−0.3	−2.8	−2.7	−3.7	−3.6	−3.8	−6.3	−3.6	−1.8	−0.7	−7.0	−2.8	−2.5	−2.9	−3.9	−6.2	−7.0	−7.7	−4.4
r	1978–1989	−6.9	−9.5	−6.6	−8.0	−7.8	−7.8	−8.5	−4.9	−5.1	−5.3	−5.8	−8.8	−8.4	−4.7	−6.3	−9.2	−6.8	−8.8	−5.1	−5.8	−7.6	−13.2	−8.6	−7.8	−7.8	−8.6	−4.8	−3.7	−8.5	−8.7	−15.5	−12.5	−11.2	−8.8	−5.1	−7.6	−12.1	n.a.
s	1855–1989	n.a.	−4.4	−4.1	−2.8	−0.2	n.a.	−2.2	−2.1	n.a.	−2.2	n.a.	−1.7	−1.5	−1.8	n.a.	−2.4	−2.8	−2.5	n.a.	−2.8	−2.4	−3.8	−2.8	n.a.	−4.5	−4.8	−2.7	−4.8	−5.0	−4.1	−4.8	−4.7	−4.9	−4.8	−4.1	−3.5	−2.7	n.a.

Chandeleur Island gulfside summary

Years	Sum	Avg	STD	Total Range		Count
1855–1922	−360.0	−5.3	4.3	0.8	−14.8	68
1922–1951	−441.0	−5.6	3.7	3.8	−18.0	79
1951–1978	−828.8	−10.0	8.4	−0.7	−52.5	83
1978–1989	−1011.6	−12.2	6.8	−0.7	−27.5	83
1855–1989	−487.4	−6.5	4.1	−0.2	−17.8	75

TABLE 44.—*Area changes for Chandeleur Island from 1855 to 1989*

Date	Area (ha)	Change (ha)	% Change	Rate (ha/yr)	Projected Date of Disappearance
1855 1922	2,763 2,485	-278	-10%	-4.1	2528
1922 1951	2,485 2,588	103	4%	3.6	N.A.
1951 1978	2,588 1,796	-792	-31%	-29.5	2041
1978 1989	1,796 1,749	-47	-3%	-4.5	2360
1855 1989	2,763 1,749	-1,014	-37%	-7.6	2218

TABLE 45.—*Area changes of North Islands from 1855 to 1989*

Date	Area (ha)	Change (ha)	% Change	Rate (ha/yr)	Projected Date of Disappearance
1855 1922	589 391	-198	-34%	-2.9	2057
1922 1951	391 280	-111	-28%	-3.9	2023
1951 1978	280 110	-170	-61%	-6.1	1996
1978 1989	110 109	-1	-1%	-0.1	3079
1855 1989	589 109	-480	-81%	-3.6	2019

TABLE 46.—*Area Changes of the New Harbor Islands from 1855 to 1989*

Date	Area (ha)	Change (ha)	% Change	Rate (ha/yr)	Projected Date of Disappearance
1855 1922	72 94	22	31%	0.3	N.A.
1922 1951	94 70	-24	-25%	-0.8	2039
1951 1978	70 63	-7	-10%	-0.3	2188
1978 1989	63 75	12	19%	1.2	N.A.
1855 1989	72 75	3	4%	.02	N.A.

TABLE 47.—*Area changes of the Freemason Islands from 1855 to 1989*

Date	Area (ha)	Change (ha)	% Change	Rate (ha/yr)	Projected Date of Disappearance
1855 1922	218 100	-118	-54%	-1.8	1978
1922 1951	100 52	-48	-48%	-1.7	1982
1951 1978	52 21	-31	-60%	-1.1	1997
1978 1989	21 12	-9	-43%	-0.8	2002
1855 1989	218 12	-206	-94%	-1.5	1997

See page 46 for explanation of numbers.

CLASSIFICATION OF SHORELINE CHANGE

Classification of the distribution and rate of change along Louisiana's barrier shoreline has been compiled and presented in past studies (Morgan and Larimore, 1957: Adams and others, 1978: Penland and Boyd, 1981; Morgan and Morgan. 1983: Dolan and others. 1985; Britsch and Kemp. 1990). These studies, however, were compiled using various methodologies. techniques, time periods. scales. and accuracy standards. which may have led to inconsistencies. Furthermore, they neither use rectified aerial photography nor discuss total potential error in detail. This study differs from previous work because it is based on approximately 880 shore-normal transects derived from digital shorelines compiled from large-scale data sources (1:33,000 or larger) using the most advanced computer mapping technology available. Moreover. temporal data were comprehensive from the 1850's to 1989, providing both long-term and short-term rates of change, and spatial consistency was maintained among data sources (table 48).

Shoreline movement along Louisiana's barrier shoreline was divided into three broad categories based on direction and rate (m/yr) of change: shoreline advance, stability, and retreat (summary map). For this study, the terms advance and retreat were used to describe shoreline movement in contrast to the terms erosion and accretion, which imply volumetric changes. For example, retreating barrier islands can preserve volume when migrating landward (both the gulf and bay shorelines) and therefore, are not eroding but merely migrating.

Based on the adopted classification scheme, the summary map illustrates that the majority of Louisiana's barrier shoreline is suffering from high rates of coastal retreat. The Timbalier Islands section of the Bayou Lafourche barrier shoreline experienced the highest average rate of landward migration. The Plaquemines barrier system, however. experienced the lowest average rate of shoreline change at -5.5 m/yr between 1884 and 1988. Only six small areas had stable or advancing shorelines: the western portions of Timbalier, Grand Terre (Barataria Pass area), and Shell islands; the eastern portion of Grand Isle; the area east of Fontanelle Pass; and the southern portion of Breton Island. These stable or accretionary areas are related to spit processes in conjunction with an adjacent tidal entrance, except the area east of Fontanelle Pass, which is related to the capture of longshore sediment transport by jetties.

CONCLUSIONS

Louisiana's barrier island systems have undergone landward migration, area loss. and island narrowing as a result of a complex interaction among subsidence, sea level rise. wave processes. inadequate sediment supply. and intense human disturbance. Consequently. the structural continuity of the barrier shoreline weakens as the barrier islands narrow, fragment. and finally disappear. In the past 100 years. total barrier island area in Louisiana has declined 55% at a rate of 63 ha/yr. This deterioration will continue to destroy Louisiana's coastline until coastal restoration techniques that complement natural processes are implemented to restore and fortify the shoreline.

The Isles Dernieres barrier system experienced retreat rates along the gulf shoreline that averaged 11.1 m/yr between 1887 and 1988, while the bayside rate of change averaged -0.6 m/yr between 1906 and 1988. Erosion of the gulf and bay shorelines caused island width to narrow from 1,171 m in the 1890's to 375 m in 1988. Consequently, gulf and bay shorelines are converging to cause the core of the barrier island arc to remain essentially stationary through time. Moreover, the area of Isles Dernieres decreased from 3,532 ha in 1890's to 771 ha in 1988, which is a loss of 2,761 ha at a rate of 28.2 ha/yr. The 2,761-ha loss represents a 78 percent decrease in island area since the 1890's. If this rate of loss continues, Isles Dernieres is projected to disappear and evolve into a subaqueous, inner-shelf shoal by the year 2015.

The Timbalier Islands experienced landward migration along the gulf and bay shorelines at average rates of -15.2 m/yr and 11.7 m/yr, respectively. However, Timbalier and East Timbalier islands must be examined separately to provide a more accurate representation of shoreline movement in response to dominant coastal processes. Between 1887 and 1988, the gulf shoreline of Timbalier Island retreated landward at 5.0 m/yr while the bay shoreline migrated seaward at 2.4 m/yr. But more importantly, Timbalier Island migrated laterally by spit processes over 6.5 km to the west. Also. island width narrowed from 1,293 m in 1887 to 415 m in 1988. The area of Timbalier Island decreased from 1,485 ha in 1887 to 542 ha in 1988, which is a loss of 64 percent, or 943 ha, at a rate of 9.3 ha/yr. At this rate, Timbalier Island is not projected to disappear until the year 2046, but short-term rates indicate a more serious problem, with a projected disappearance date by the year 2000. East Timbalier Island experienced the highest gulfside retreat rate (-23.1 m/yr) for any barrier island shoreline, not only in Louisiana but in the county. Correspondingly, the bay shoreline raced landward as well, averaging 24.0 m/yr. Initially. the rapid rate of landward migration of the gulf and bay shorelines was caused by washover processes. but extensive seawall construction beginning in the late 1950's terminated this process. Interestingly. width and area for East Timbalier Island increased between 1887 and 1988. Average island width increased from 264 to 333 m and area expanded from 193 ha in 1887 to 238 ha in 1988, which is a gain of 23 percent. or 45 ha, at a rate of 0.4 ha/yr.

Caminada-Moreau Headland and Grand Isle experienced shoreline retreat at an average gulfside rate of -7.9 m/yr between 1887 and 1988, while at the same time, the bay shoreline was essentially stable. However. for shoreline change analysis, this coastal segment was further divided into the Caminada-Moreau Headland and Grand Isle. The gulf shoreline of the Caminada-Moreau Headland averaged 13.3 m/yr of shoreline retreat between 1887 and 1988, while the bay shoreline advanced 4.1 m/yr for the same period. In contrast. the average gulfside rate of shoreline change along Grand Isle advanced 0.9 m/yr, while the bay shoreline retreated at an average rate of 1.0 m/yr. The average area of Grand Isle decreased only slightly from 1,059 to 960 ha between 1887 and 1988, which is a loss of only 9 percent at a rate of 1.0 ha/yr. At this rate, Grand Isle is projected to disappear in the year 2948. Average width for Grand Isle also showed stability, remaining constant at approximately 690 m. The eastern end of Grand Isle was the only portion along this barrier shoreline to experience shoreline advance. Beach replenishment probably contributed to Grand Isle's stability over the years.

The Plaquemines barrier system experienced the lowest rate of gulfside retreat, averaging 5.5 m/yr with a bayside rate of 0.4 m/yr between 1884 and 1988. Two islands along the Plaquemines shoreline were examined individually: Grand Terre and Shell. Grand Terre Islands migrated landward along the gulf shoreline at -3.9 m/yr for the period 1884 and 1988, while the bay shoreline migrated seaward at 2.2 m/yr. Therefore, the core of the island was stationary, causing the width to narrow from 909 to 530 m and the area to diminish from 1,699 ha in 1884 to 513 ha in 1988; this is a loss of 70 percent at a rate of 11.4 ha/yr. If this rate of land loss continues, Grand Terre Islands are projected to disappear by the year 2033. Shell Island migrated landward along the gulf shoreline more rapidly than Grand Terre Islands, averaging 6.0 m/yr. But, the bay shoreline also migrated landward at 3.4 m/yr, causing the entire island to migrate landward instead of maintaining a stationary position. The width of Shell Island narrowed from 177 to 122 m between 1884 and 1988 with a similar decrease in area from 127 to 69 ha. This is a loss of 46 percent at a rate of 0.6 ha/yr. If this long-term rate of land loss continues, Shell Island will not disappear until the early twenty-second century. However. the short-term rate loss of 5.0 ha/yr between 1973 and 1988 projects a disappearance date of 2002.

The South Chandeleur Islands underwent the second highest average rate of gulfside retreat between 1869 and 1989 at 11.6 m/yr, with the bay shoreline migrating landward also at a high rate of 10.7 m/yr. During rapid landward migration, average barrier width decreased from 384 to 232 m. Area decreased from 784 to 441 ha, representing a land loss of 44 percent, at a rate of 2.9 ha/yr. Individually, Breton Island migrated landward along the gulf and bay shorelines between 1869 and 1989 at -5.7 and 3.9 m/yr, respectively. Similarly, area was reduced from 332 to 164 ha, which is a 51 percent loss at an average rate of 1.4 ha/yr. For the same period. Grand Gosier and Curlew islands migrated landward at even higher rates along the gulf and bay shorelines at 16.2 and 15.0 m/yr, respectively. Area decreased from 453 to 277 ha, which is a 39 percent loss at an average rate of 1.5 ha/yr. Overall. the South Chandeleur Islands are narrowing as they rapidly migrate landward. This type of migration is similar to East Timbalier and Shell islands.

The North Chandeleur Islands are characterized by an average retreat rate of 6.5 m/yr along the gulf shoreline between 1855 and 1988. The bay shoreline migrated landward also but was twice as slow as the gulf shoreline at 2.9 m/yr. As a result, average island width narrowed by about 50 percent from 941 m in 1855 to 473 m in 1989, with a 37 percent decrease in island area from 2,763 to 1,749 ha. The total loss was 1,014 ha at an average rate of 7.6 ha/yr. Once again. the North Chandeleur Islands display a narrowing trend as they rapidly migrate landward similar to East Timbalier, Shell, and South Chandeleur islands.

Finally, the Louisiana barrier shoreline is dominated by two types of island evolution: *landward rollover and in-place breakup.* Landward rollover is dominated by washover processes capable of eroding and transporting sediment from the gulf shoreline. across the barrier island, and depositing this sediment along the bay shoreline; both the gulf and bay shorelines migrate landward. This appears to be associated with barrier islands having sufficient sediment to migrate landward under relative sea level rise (East Timbalier Island, 1887 to 1956; Chandeleur Island). When in-place breakup occurs, sediment is not transported across the entire barrier because there is an inadequate sediment supply and/or the barrier island is too wide to be completely overwashed. Seaward migration along the bayside shoreline occurs in response to wave activity (erosion) and subsidence. This type of evolution is associated with barrier island systems that are rapidly deteriorating and have short life expectancies (Isles Dernieres, Grand Terre Islands). Systems where in-place breakup occurs are the most critical areas of barrier island land loss and need the greatest attention

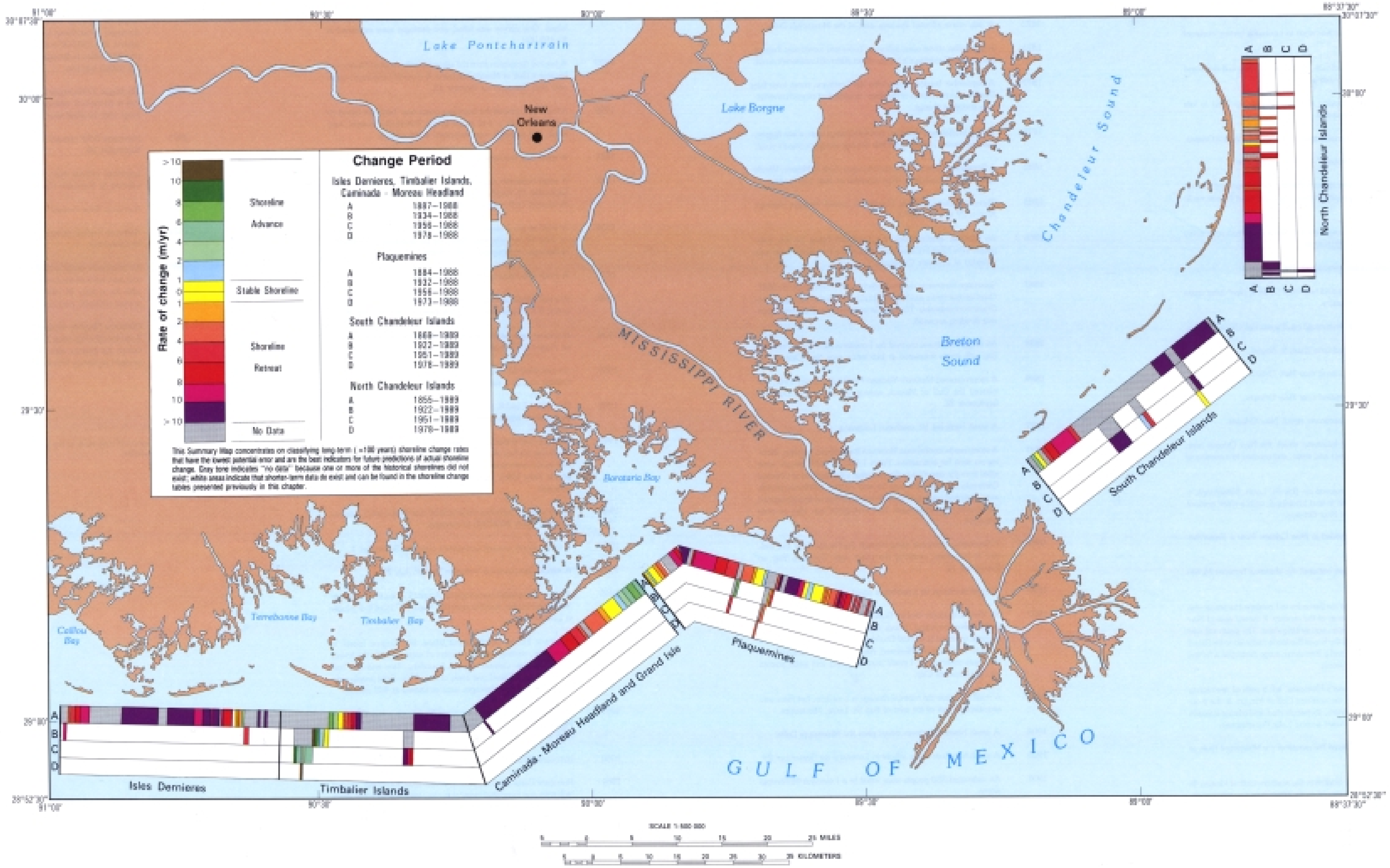
TABLE 48.—*Summary of Louisiana's barrier island shoreline change statistics.*

		GULFSIDE SHORELINE CHANGE RATES (m/yr)						ISLAND AREA CHANGE RATES (ha/yr)		PROJECTED DATE OF DISAPPEARANCE (yr)		BAYSIDE SHORELINE CHANGE RATES (m/yr)					
		Long Term*			Short Term**			Long Term*	Short Term**	Long Term*	Short Term**	Long Term*			Short Term**		
BARRIER SYSTEM	ISLAND/BEACH	Avg.	STD	Total Range	Avg.	STD	Total Range					Avg.	STD	Total Range	Avg.	STD	Total Range
1. Isles Dernieres		-11.1	5.2	3.4 / -23.2	-19.2	12.7	6.0 / -64.3	-28.2	-47.2	2015	2004	-0.6	5.8	23.5 / -4.9	-2.7	15.5	43.4 / -24.3
	Raccoon	-7.2	2.1	-3.4 / -9.7	-17.7	7.3	-8.2 / -34.0	-7.7	-6.8	1999	2000	-2.4	0.9	-1.2 / -4.3	2.0	16.1	31.4 / -21.9
	Whiskey	-16.3	2.6	-12.9 / -22.0	-30.1	16.3	-11.6 / -64.3	-3.7	-12.7	2042	2007	-1.7	1.8	3.5 / -4.5	5.4	17.7	43.4 / -19.0
	Trinity	-11.0	1.2	-9.8 / -14.4	-17.8	4.5	-9.9 / -25.3	---	-18.9	---	2007	-1.6	2.3	4.0 / -4.6	-8.4	12.5	38.4 / -24.3
	East	-4.8	3.9	3.4 / -10.7	-8.7	9.5	6.0 / -21.0	---	-9.0	---	1996	-2.7	1.4	-0.7 / -4.9	-8.8	7.0	0.1 / -24.3
	Wine	-22.9	0.4	-22.5 / -23.2	---	---	--- ---	-1.5	---	1995	---	22.4	0.9	23.5 / 21.3	---	---	--- ---
2. Bayou Lafourche																	
Timbalier Islands		-15.2	11.6	8.0 / -33.3	-14.0	23.7	27.6 / -84.6	-8.9	-71.5	2076	1999	11.7	15.0	32.7 / -14.6	-7.8	24.8	52.2 / -122.7
	Timbalier	-2.4	5.9	8.0 / -13.0	-7.0	16.5	27.6 / -54.0	-9.3	-45.7	2046	2000	-5.0	3.1	-1.0 / -15.0	-14.1	26.7	52.2 / -122.7
	East Timbalier	-23.1	4.4	-16.3 / -33.3	-21.2	28.7	4.6 / -84.6	0.4	-25.7	---	1997	24.0	4.3	33.0 / 18.0	-1.2	21.4	41.1 / -61.3
Caminada—Moreau Headland and Grand Isle		-7.9	8.4	6.2 / -20.0	-6.5	11.5	16.7 / -42.0	---	---	---	---	-0.1	2.4	7.0 / -2.8	-3.0	4.3	5.5 / -13.0
	Caminada—Moreau Headland	-13.3	5.6	-2.9 / -20.0	-13.6	7.8	-2.8 / -42.0	---	---	---	---	4.1	1.9	7.0 / 1.9	-1.8	1.4	0.4 / -3.7
	Grand Isle	0.9	3.1	6.2 / -3.4	5.2	5.7	16.7 / -2.5	-1.0	1.1	2948	---	-1.0	1.3	2.8 / -2.8	-3.2	4.6	5.5 / -13.0
3. Plaquemines		-5.5	4.5	1.9 / -15.6	-9.9	11.1	14.9 / -70.1	---	---	---	---	0.4	4.5	12.5 / -4.7	3.7	17.6	66.1 / -19.8
	Grand Terre	-3.9	3.5	1.9 / -9.2	-7.9	6.5	5.9 / -15.6	-11.4	-10.8	2033	2036	-2.2	1.9	1.5 / -4.7	-1.2	6.8	17.2 / -7.5
	Shell	-10.1	2.9	-2.5 / -12.5	-24.2	17.6	-3.6 / -70.1	-0.6	-5.0	2103	2002	7.9	12.0	12.5 / 2.4	20.6	12.4	66.1 / -1.1
4. Chandeleur Islands																	
South Chandeleur Islands		-11.6	6.5	5.9 / -21.1	-19.7	15.9	6.9 / -41.3	-2.9	13.3	2199	---	10.7	6.9	22.6 / -7.7	19.8	20.8	60.1 / -8.9
	Breton	-5.7	4.7	5.9 / -9.2	-4.1	10.2	3.8 / -23.7	-1.4	2.2	2106	---	3.9	5.8	10.0 / -7.7	-1.2	3.1	5.8 / -3.7
	Grand Gosier/ Curlew	-16.2	3.3	-6.1 / -21.1	-23.9	14.5	6.9 / -41.3	-1.5	11.1	2174	---	15.0	2.9	22.6 / 11.1	26.8	19.4	60.1 / -8.9
North Chandeleur Islands																	
	Chandeleur	-6.5	4.1	-0.2 / -17.6	-12.2	6.6	-3.7 / -27.5	-7.6	-4.5	2218	2360	2.9	3.3	15.0 / -2.0	5.3	11.9	46.1 / -5.0
	North	---	---	--- ---	---	---	--- ---	-3.6	-0.1	2019	3079	---	---	--- ---	---	---	--- ---
	New Harbor	---	---	--- ---	---	---	--- ---	0.0	1.2	---	---	---	---	--- ---	---	---	--- ---
	Freemason	---	---	--- ---	---	---	--- ---	-1.5	-0.9	1997	2002	---	---	--- ---	---	---	--- ---

* Long Term = Shoreline record covering more than 100 years.
(except long-term island area rate for Whiskey Island — 54 years)

** Short Term = Shoreline record for the last 10 — 15 years.

Summary Map



This Summary Map concentrates on classifying long-term (>100 years) shoreline change rates that have the lowest potential error and are the best indicators for future predictions of actual shoreline change. Gray tone indicates "no data" because one or more of the historical shorelines did not exist; white areas indicate that shorter-term data do exist and can be found in the shoreline change tables presented previously in this chapter.

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Appendix A Louisiana’s Hurricane History

YEAR	STORM
1711	A major three-day storm was reported in early September just south of Lake Pontchatrain.
1722	The first recorded great hurricane in Louisiana history occurred in September.
1723	On September 11 a hurricane struck New Orleans and destroyed nearly all homes and buildings.
1772	A storm disrupted shipping along the Mississippi River in late August and early September.
1776	A minor storm did minimal damage to the buildings in New ‘&leans.
1778	A storm between October 7-10 destroyed Balize.
1779	On August 12 a severe storm battered New Orleans and the surrounding region, destroying homes, ships and other human-made features.
1780	An August 24 storm struck the Louisiana coast and sunk every ship anchored in the Mississippi.
1781	A m&August storm passed near New Orleans.
1793	A mid-August storm passed near New Orleans. destroying crops and devastating rural areas.
1794 *	A mid-August storm devastated rural areas near New Orleans
1794 *	A storm struck the Louisiana coast in August.
1800	A mid-August storm passed near New Orleans
1811	A mid-August storm passed near New Orleans
1812 *	A violent mid-August hurricane struck New Orleans.
1812 *	On August 19 a great hurricane struck the New Orleans area. destroyed the city’s levees and ships, and resulted in a number of deaths.
1819	Although primarily centered on Bay St. Louis, Mississippi, a July storm was also felt in east Louisiana, with a small amount of damage recorded in New Orleans.
1821	Little damage was recorded in New Orleans from a September storm.
1822	In early July, a hurricane battered the shoreline between Mobile and New Orleans.
1831	This storm. described as the Barbados to Louisiana Hurricane, was one of the great hurricanes of the century. It moved east of New Orleans, destroying homes and sinking ships. The death toll was estimated at 1,500. On the Isle of Barataria (believed to be Grand Isle) the storm’s winds and a 2-m storm surge destroyed a fishing village and killed 150 people.
1837	A storm called the “Racer’s Hurricane” left a path of destruction over 3,000 km long in the northern Gulf of Mexico. In the inundated areas of New Orleans, six people died, and marine interests suffered considerable losses around Lake Pontchartrain.
1846	A rare April storm battered the mouth of the Mississippi River at Balize.
1848	Three hurricanes made landfall in the northern Gulf of Mexico. In early August, one storm moved up the Mississippi damaging crops, but property losses were apparently minimal.
1855	A September 15 storm destroyed the Gulf coast from Lake Pontchartrain to Gulf Shores.
1856	On Sunday, August 10, the Isles Dernieres storm decimated Louisiana’s coast. The resort community at Isles Dernieres was destroyed, and approximately 400 people died.
1860	Three hurricanes struck the middle Gulf Coast in late summer and early fall. One of them inundated property adjacent to Lake Pontchartrain and was responsible for 13 deaths.
1865	A September storm concentrated its energy between Orange. Texas, and Cameron, Louisiana.
1867	Galveston, Texas, and western Louisiana were devastated by this storm. but damage to south Louisiana’s coastal communities was minor.
1872	A July storm affected the area east of the Mississippi Delta
1875	A September storm came ashore in Texas and turned east through the middle of Louisiana; it had no direct effect on Louisiana’s coast.
1877	A September hurricane paralleled the Louisiana coast from Isles Dernieres to the mouth of the river-a track that caused considerable shoreline change.
1879	Making landfall near Vermilion and Atchafalaya bays, a late-August. early-September hurricane did little damage along Louisiana’s coast.
1882	A September hurricane affected the entire Gulf of Mexico. Winds at Port Eads, Louisiana, were recorded at over 145 km/hr.
1885	Three hurricanes brushed Louisiana’s coastal margins between August 29 and October 2.
1886	An October storm struck the Louisiana-Texas border. Fifty people were killed in Cameron Parish, and a l-m storm surge was recorded at Cheniere Caminada.
1887	Seventeen hurricanes were recorded in the United States in 1887. One October storm made landfall in Louisiana and damaged New Orleans considerably. The city’s levees were breached, and extensive flooding occurred.
1888	An August hurricane crossed the Louisiana coast near Vermilion Bay with winds measured at 145 km/hr near New Orleans.
1889	A storm crossed Mexico’s Yucatan Peninsula, turned north, and crossed the Gulf of Mexico, nicking the Mississippi Delta on September 22.
1892	A small hurricane hit southeast Louisiana.
1893	A storm made landfall near Barataria Bay without warning, allowing no time for evacuation. From l,000 to 2,000 people were killed from the storm’s two-day rampage. Communities at Cheniere Caminada and Grand Isle were hit hard. At least 150 fishing vessels were sunk and numerous shrimp-drying platforms and associated settlements were destroyed. Fort Livingston was also severely damaged.
1897	A September hurricane came through the Florida Keys and took aim at Louisiana, crossing the coast near Vermilion Bay on September 12.
1898	A small hurricane hit Louisiana’s coast.
1900	Six thousand people died on September 8 when a hurricane inundated Galveston Island, Texas, with a 6-m storm surge. Minimal damage occurred in coastal Louisiana, but the water rose over a meter in 10 minutes at Pilottown. Almost all of New Orleans’ east bank was under water. Levees were breached, and water pared into the Crescent City.
1901	A small hurricane did minimal damage in Louisiana, but there was considerable loss of life east of Bay St. Louis, Mississippi
1904	A small November storm swept pass the Mississippi Delta.
1905	A small hurricane came ashore in Louisiana on September 29.
1906	An estimated 350 people were killed in a Louisiana-Mississippi storm.
1909	About 350 people died in September when a storm flooded most of the Louisiana coast with wind speeds of over 200 km/hr and a 5-m storm surge at Timbalier Island and the hamlet of Sea Breeze. The community at Manila Village was nearly demolished
1915	Two hundred seventy-five people died when a hurricane struck the Mississippi Delta on September 29. In New Orleans, 25,000 structures with an estimated value of $13 million were damaged or destroyed. A 4-m storm surge was reported. Grand Isle’s storm surge was estimated at three meters; nearly the entire island was under water.
1916	A small October storm affected the area east of the Mississippi Delta, but did minimal damage
1918	An extreme storm killed 34 people and did $5 million in damage to the communities in western Louisiana.
1920	A small September hurricane crossed Louisiana’s coast near Last Island. One person was killed, and damages were estimated at $1,450,000.
1923	A tropical depression from the eastern Pacific crossed Mexico and became a Gulf of Mexico hurricane. It crossed Louisiana’s coast near Isles Dernieres on October 15.
1926	A hurricane crossed the Louisiana coast near Timbalier Island on August 26 with a 3-m storm surge. Twenty-five people were killed, and damages were estimated at $4 million.
1931	A small July hurricane did minor damage to Louisiana’s coast.
1932	A small hurricane made landfall at Morgan City, Louisiana, on September 19. Another storm in October along the Louisiana and Mississippi Gulf coasts did minor damage.
1934	A small storm crossed the Louisiana coast near Isles Dernieres on June 16 and was responsible for six deaths and $2,605,000 in damages at Morgan City, Louisiana.
1936	A small July hurricane did minor damage to Louisiana’s coast.
1937	A small September hurricane did minor damage to Louisiana’s coast, but dropped 42 cm of precipitation on New Orleans
1938	Hurricane-force winds battered the Louisiana and Texas coasts on August 14. Damage was estimated at $243,000.
1939	An estimated $1.7 million in damages were assessed from New Orleans east as a result of a September 26 hurricane.
1940	On August 7 and 8, the Louisiana and Texas coasts were lashed by hurricane winds and a l-m storm surge.
1947	Over 2.5 m of water flooded New Orleans from a September hurricane that tracked directly over New Orleans. It generated a surge that easily overtopped the region’s protective levees. Thirty-fan people were killed, and over $100 million in damages were assessed.
1948	A September 4 hurricane made landfall near Grand Isle, Louisiana recorded nearly $900,000 in damages.
1949	A minor storm crossed Louisiana’s coast on September 4.
1954	A minor storm crossed Vermilion Bay on July 29.
1955	A minor storm killed two people on August 1 along the Louisiana-Mississippi border. Another storm on August 27 killed four people in Louisiana.
1956	Hurricane Flossy struck Grand Island and Eugene Island in September, putting over two meters of water outside the levees protecting New Orleans’ eastern boundary. Two and one half meters of water flowed over areas of Grand Isle. Eight people were killed, and property damages were estimated at $22 million.
1957	Hurricane Audrey’s 4-m storm surge hit the coast near Calcasieu Pass on June 27. Many people refused to evacuate and over 500 died. Property damages were estimated at $150 million.
1960	Hurricane Ethel passed near the Mississippi Delta
1961	Hurricane Carla, one of the most severe Gulf hurricanes, caused high tides and inundated many of the low-lying communities along Louisiana’s coast with from 1-2 m of water.
1964	Hurricane Hilda hit Louisiana’s coast in late September and early October. Hilda caused considerable damage to offshore and coastal oil installations and generated a surge height of 1.5 m at Grand Isle. The storm caused considerable damage to the beach at Grand Isle and cut through the western end of the island and Cheniere Caminada.
1965	Hurricane Betsy roared into southern Florida and Louisiana on September 8 with winds over 250 km/hr. Grand Isle was inundated with nearly a 3-m surge height. The entire island was covered, and nearly all buildings were swept away, demolished, or severely damaged. In southeast Louisiana, 81 people were killed, 17,600 injured, and 250,000 evacuated. The storm was responsible for over $1.4 billion in damages within an inundated area that exceeded 1.2 million hectares.
1969	On August 17 Hurricane Camille-one of the most violent storms ever to hit the U.S. mainland-killed over 300 people. A 6-m storm surge was recorded near New Orleans.
1971	Hurricane Edith crossed the Louisiana coast near Cameron on September 16.
1974	Louisiana citizens from Eugene Island to Lake Charles were affected by Hurricane Carmen
1977	Hurricane Babe crossed Louisiana’s coast near Point-Au-Fer.
1979	Hurricane Frederic ravaged southern Alabama, and Hurricane Bob hit Grand Isle.
1985	Six hurricanes made landfall in the United States. Danny, Elena. and Juan battered the Louisiana coast. These storms were responsible for at least $4 billion in property damages. Three million coastal residents were evacuated.
1988	Hurricane Florence crossed the Mississippi Delta on September 8 and brought high water to Mississippi. Eight days later, Hurricane Gilbert hit Mexico with 300 km/hr winds. Its waves severely eroded Louisiana’s barrier islands.

* These accounts may refer to the same storm but the historical material is inconclusive.

Appendix B Coastal Erosion and Wetlands Loss Tables

TABLE B1.—*Rate of shoreline change for U.S. coastal states and regions [Symbol used: —, no data]*

Region		Mean (m/yr)[1]	Standard Deviation	Total Range	N[2]
Atlantic Coast		-0.8	3.2	25.5 to 24.8	510
	Maine	-0.4	0.6	1.9 to -0.5	16
	New Hampshire	0.0	—	-0.5 to -0.5	4
	Massachusetts	-0.9	1.9	4.5 to -4.5	48
	Rhode Island	-0.5	0.1	-0.3 to -0.7	17
	New York	0.1	3.2	18.8 to -2.2	42
	New Jersey	-1.0	5.4	25.5 to -15.0	39
	Delaware	0.1	2.4	5.0 to -2.3	7
	Maryland	-1.5	3.0	1.3 to -8.8	9
	Virginia	-4.2	5.5	0.9 to -24.8	34
	North Carolina	-0.6	2.1	9.4 to -6.0	101
	South Carolina	-2.0	3.8	5.9 to -17.7	57
	Georgia	0.7	2.8	5.0 to -4.0	31
	Florida	-0.1	1.2	5.0 to -2.9	105
Gulf of Mexico		-1.8	2.7	8.8 to -15.3	358
	Florida	-0.4	1.6	8.8 to -4.5	118
	Alabama	-1.1	0.6	0.8 to -3.1	16
	Mississippi	-0.6	2.0	0.6 to -6.4	12
	Louisiana	-4.2	3.3	3.4 to -15.3	106
	Texas	-1.2	1.4	0.8 to -5.0	106
Pacific Coast		0.0	1.5	10.0 to -5.0	305
	California	-0.1	1.3	10.0 to -4.2	164
	Oregon	-0.1	1.4	5.0 to -5.0	88
	Washington	-0.5	2.2	5.0 to -3.9	46
	Alaska	-2.4	2.0	2.9 to -6.0	69

[1] Negative values indicate erosion; positive values indicate accretion.

[2] Total number of 3-minute grid cells over which the statistics are calculated.

(Data from U.S. Geological Survey, 1988.)

TABLE B2.—*Distribution of coastal wetlands in the United States [Symbol used: —, data not available]*

Region and State		Wetland Area (hectares) Salt Marsh	Fresh Marsh	Tidal Flats	Swamp	Total
Northeast						
	Maine	6,723	10,409	23,612	10,125	50,868
	New Hampshire	3,038	—	—	—	3,038
	Massachusetts	19,481	6,116	16,808	10,085	52,488
	Rhode Island	3,200	0	0	23,126	26,325
	Connecticut	6,723	—	—	—	6,723
	New York	10,814	1,377	—	—	12,191
	Pennsylvania	0	324	0	0	324
	New Jersey	88,047	8,789	19,683	191,282	307,800
	Delaware	31,631	2,876	4,577	49,977	89,060
	Maryland	66,258	10,368	729	7,857	85,212
	Virginia	61,682	8,100	—	—	69,782
	Subtotal	297,594	48,357	65,408	292,451	703,809
Southeast						
	North Carolina	64,314	37,260	—	853,538	955,112
	South Carolina	149,648	26,123	—	—	175,770
	Georgia	151,592	12,758	3,848	115,830	284,027
	Florida (Atlantic)	38,840	155,277	—	104,895	299,012
	Subtotal	404,393	231,417	3,848	1,074,263	1,713,920
Gulf of Mexico						
	Florida (Gulf)	174,677	31,388	—	393,134	599,198
	Alabama	5,913	4,293	—	61,277	71,483
	Mississippi	25,920	1,620	—	30,780	58,320
	Louisiana	708,183	278,964	—	177,066	1,164,213
	Texas	158,112	31,874	—	16,322	206,307
	Subtotal	1,072,805	348,139	0	678,579	2,099,523
West Coast						
	California	8,748	1,782	5,427	1,377	17,334
	Oregon	7,614	2,552	10,206	—	20,372
	Washington	9,599	7,128	891	11,826	29,444
	Subtotal	25,961	11,462	16,524	13,203	67,149
	Total	**1,800,752**	**639,374**	**85,779**	**2,058,494**	**4,584,398**
	(% of total)	(39)	(14)	(2)	(45)	(100)

Data converted to metric units from Alexander and others (1986, p. 6). Sums of some columns or rows may not exactly equal totals shown because of the conversion procedure and subsequent rounding.

TABLE B3.—*Distribution of U.S. coastal wetlands in the Gulf of Mexico [Symbol used: —, data not available]*

Region and State	County	Wetland Area (hectares) Salt Marsh	Fresh Marsh	Flats	Swamp	Total
Gulf of Mexico						
Florida	Bay	2,683	332	—	17,358	20,373
	Charlotte	4,827	—	—	6,938	11,765
	Citrus	12,410	—	—	6,233	18,644
	Collier	16,902	—	—	33,180	50,082
	Dixie	9,530	—	—	18,968	28,498
	Escambia	1,102	—	—	5,375	6,477
	Franklin	8,310	930	—	58,602	67,842
	Gulf	256	2,652	—	47,909	50,817
	Hernando	4,564	—	—	9,784	14,348
	Hillsborough	993	233	—	3,740	4,966
	Jefferson	1,048	—	—	7,863	8,911
	Lee	5,751	—	—	17,485	23,236
	Levy	15,881	85	—	5,319	21,285
	Manatee	438	111	—	2,415	2,965
	Monroe	64,613	35,304	—	89,895	189,812
	Okaloosa	264	—	—	10,881	11,145
	Pasco	1,501	—	—	1,347	2,848
	Pinellas	—	—	—	2,421	2,421
	Santa Rosa	3,217	18	—	16,099	19,333
	Sarasota	362	—	—	380	743
	Taylor	9,686	—	—	18,626	28,312
	Wakulla	7,936	723	—	3,455	12,114
	Walton	1,488	—	—	12,065	13,553
	Subtotal	174,663	31,398	0	393,130	599,190
Alabama	Baldwin	1,601	2,859	—	42,489	46,948
	Mobile	4,328	1,430	—	18,786	24,543
	Subtotal	5,929	4,289	0	61,275	71,492
Mississippi	Hancock	8,910	608	—	7,290	16,808
	Harrison	3,240	203	—	2,228	5,670
	Jackson	13,779	810	—	21,263	35,843
	Subtotal	25,929	1,620	0	30,780	58,329
Louisiana	Assumption	0	0	—	0	0
	Cameron	147,076	115,139	—	83	262,298
	Iberia	37,463	4,253	—	2,228	43,943
	Jefferson	28,553	7,490	—	11,543	47,586
	Lafourche	86,063	9,518	—	6,885	102,465
	Livingston	0	0	—	608	608
	Orleans	17,415	608	—	3,240	21,263
	Plaquemines	117,045	18,428	—	10,125	145,598
	St. Bernard	86,873	0	—	4,050	90,923
	St. Charles	8,100	6,885	—	7,290	22,275
	St. James	0	0	—	17,415	17,415
	St. John Bap.	2,633	1,823	—	25,718	30,173
	St. Mary	7,898	39,083	—	36,855	83,835
	St. Tammany	12,960	5,468	—	8,303	26,730
	Tangipahoa	0	5,063	—	22,275	27,338
	Terrebonne	121,095	63,383	—	17,820	202,298
	Vermilion	35,033	1,823	—	2,633	39,488
	Subtotal	708,197	278,962	0	177,066	1,164,227
Texas	Aransas	3,629	1,814	—	—	5,443
	Brazoria	17,107	2,333	—	1,296	20,736
	Calhoun	9,331	6,221	—	—	15,552
	Chambers	25,142	—	—	259	25,402
	Galveston	17,885	—	—	—	17,885
	Harris	778	58	—	4,866	5,702
	Jackson	1,296	1,296	—	—	2,592
	Jefferson	54,651	4,406	—	1,555	60,613
	Kleberg	—	4,666	—	—	4,666
	Matagorda	13,219	1,037	—	778	15,034
	Nueces	—	1,037	—	—	1,037
	Orange	10,368	3,629	—	7,258	21,254
	Refugio	1,555	1,555	—	—	3,110
	San Patricio	2,333	2,592	—	—	4,925
	Victoria	778	1,037	—	518	2,333
	Subtotal	158,112	31,882	0	16,330	206,323
Total Gulf of Mexico		**1,072,829**	**348,149**	**0**	**678,583**	**2,099,552**

Data converted to metric units from Alexander and others (1986, p. 84). Sums of some columns or rows may not exactly equal totals shown because of the conversion procedure and subsequent rounding.

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Appendix A

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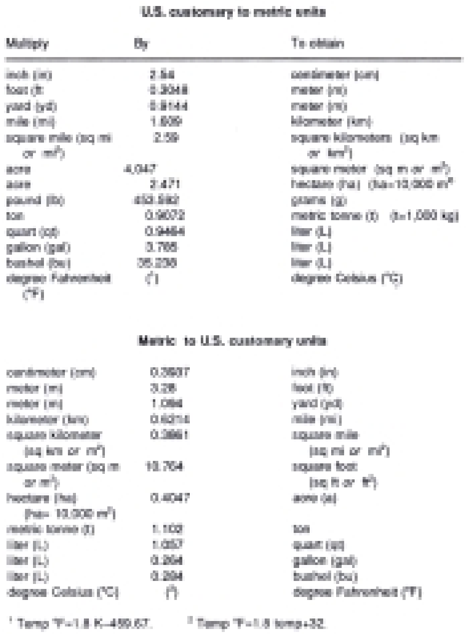
CONVERSION FACTORS

Measurements appearing in the text of the Atlas are generally given in metric units. Many of the illustrations and tables in the Atlas, however, are reprinted or only somewhat modified (with permission) from other published sources, some of which are copyrighted; therefore measurements in the cited material are presented in their original form. The following conversion table is provided to aid the reader in making conversions from metric to U.S. customary units and from U.S. customary to metric, as needed.



U.S. customary to metric units

Multiply	By	To obtain
inch (in)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
yard (yd)	0.9144	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (sq mi or mi²)	2.59	square kilometers (sq km or km²)
acre	4,047	square meter (sq m or m²)
acre	2.471	hectare (ha) (ha=10,000 m²)
pound (lb)	453.592	grams (g)
ton	0.9072	metric tonne (t) (t=1,000 kg)
quart (qt)	0.9464	liter (L)
gallon (gal)	3.785	liter (L)
bushel (bu)	35.238	liter (L)
degree Fahrenheit (°F)	(¹)	degree Celsius (°C)

Metric to U.S. customary units

Multiply	By	To obtain
centimeter (cm)	0.3937	inch (in)
meter (m)	3.28	feet (ft)
meter (m)	1.094	yard (yd)
kilometer (km)	0.6214	mile (mi)
square kilometer (sq km or m²)	0.3861	square mile (sq mi or mi²)
square meter (sq m or m²)	10.764	square foot (sq ft or ft²)
hectare (ha) (ha= 10,000 m²)	0.4047	acre (a)
metric tonne (t)	1.102	ton
liter (L)	1.057	quart (qt)
liter (L)	0.264	gallon (gal)
liter (L)	0.284	bushel (bu)
degree Celsius (°C)	(²)	degree Fahrenheit (°F)

[1] Temp °F=1.8 K–459.67. [2] Temp °F=1.8 temp+32.